POSITION LOCATOR

CROSS REFERENCE TO RELATED APPLICATION

The present invention is related to co-pending application Ser. No. 294,134, entitled "An Electronic Compass System," filed in the name of Ernest R. Harrison, the present inventor, filed on Oct. 2, 1972. The assignee of the present invention is also the assignee of this related application.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a dead reckoning position locator, and more particularly to a vector quantity computer adapted to determine distance and direction traveled by a carrier of an electrical sensor apparatus which measures heading angle in response to the earth's gravitational and magnetic fields. Still more particularly, the present invention is directed to means for computing a course of travel of a man having a sensor apparatus, comprised of strain gauge accelerometer and flux gate assemblies strapped to his leg. The invention is particularly useful in determining the wearer's course of travel, which may be, for example, a foot soldier or the like.

SUMMARY

Briefly, the subject invention is utilized in combination with sensor apparatus which provides electrical output signals corresponding to the earth's gravity vector $\overline{G}$, the acceleration vector $\overline{A}$ due to the motion of the compass, which might be, for example, the motion of the leg of the wearer of the sensor apparatus, and the earth's magnetic vector $\overline{H}$ along three mutually perpendicular axes X, Y and Z of the sensor apparatus. While the sensor apparatus is in a movement mode, the present invention includes means responsive to said electrical output signals representative of the composite $\overline{G}$ and $\overline{A}$ vector for performing a double integration with respect to time in order to determine the distance $\overline{S}$ traveled in each axis direction. During a stationary mode, the distance vector $\overline{S}$ in each of the aforesaid axis directions $\overline{S}_x + \overline{S}_y + \overline{S}_z$ is converted to North-East-vertical coordinates $\overline{S}_N + \overline{S}_E + \overline{S}_V$, utilizing the signals representative of the gravity vector $\overline{G}$ and the magnetic vector $\overline{H}$. Circuitry is additionally included for determining when the sensor apparatus is stationary for a predetermined length of time for resetting the double integrator means to zero. Also at the end of each computation cycle, the sensor output is clamped to zero to separate the acceleration vector $\overline{A}$ from the gravity vector $\overline{G}$ for the succeeding cycle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A–1C are cross sectional views of strain gauge accelerometer and flux gate magnetometer sensor apparatus utilized in combination with the subject invention;

FIG. 2 is a diagram illustrative of the operational environment of the sensor apparatus illustrated in FIGS. 1A–1C;

FIG. 3 is a vector diagram helpful in understanding the operation of the subject invention;

FIG. 4 is an electrical schematic diagram of the circuitry utilized in connection with the strain gauge sensor assembly;

FIG. 5 is an electrical schematic diagram of the flux gate magnetometer sensor assembly;

FIG. 6 is an electrical block diagram of the preferred embodiment of the subject invention; and

FIG. 7 is an electrical block diagram illustrative of a multiplexed multiplier arrangement for providing the necessary computing operations in accordance with the subject invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and more particularly to FIGS. 1A, 1B and 1C, there is disclosed the physical embodiment of a composite strain gauge accelerometer and flux gate magnetometer sensor apparatus described and claimed in the above cross-referenced related application. Reference numeral **10** generally denotes the sensor apparatus comprised of, inter alia, a hollow, cylindrical body portion **12** having an opening in one end thereof with a screw threaded end portion **14** fitted thereto. The elements **12** and **14** are comprised of substantially non-magnetic material. Interiorally of the first body portion **12** is located a second hollow, cylindrical body portion **16** being held in a substantially rigid spaced relationship with the outer body portion **12** by means of a thin walled tube **18** secured to the end wall **20** of the outer body portion **12.** A screw threaded end piece **22** is fitted to the inner body portion **12** as shown in FIG. 1A. The outer and inner body portions **12** and **16**, respectively, are thus coaxial along the Y axis shown in FIG. 1A.

Three pairs of strain gauges A and C, B and D, B' and D', are mounted on the outer surface **19** of the thin walled tube **18** in mutually opposed relationship. A reference strain gauge R is mounted on the inner surface of the end wall **20** of the outer housing portion as shown in FIG. 1C. The strain gauges A, B, . . . R, define a three axis strain gauge accelerometer assembly for providing three orthogonal component output signals $\overline{G}_x + \overline{A}_x$, $\overline{G}_y + \overline{A}_y$, and $\overline{G}_z + \overline{A}_z$, corresponding to the earth's gravitational field vector $\overline{G}$ and the acceleration vector $\overline{A}$ of the carrier of the apparatus **10** which may be, for example, a man as shown in FIG. **2** with the apparatus **10** strapped to his leg. The three orthogonal output signals $\overline{G}_x + \overline{A}_x$, etc. correspond to the three mutually orthogonal X, Y and Z axes through the body portions **12** and **16** as shown in FIGS. 1A and 1B. It should be pointed out, however, that when the sensor apparatus **10** is stationary, e.g., the wearer's foot is on the ground the acceleration vector A is zero, leaving only the gravity vector $\overline{G}$. The Y axis corresponds to the central axis of the body portions **12** and **16** while the X and Z axes are mutually perpendicular axes at a plane normal to the central axis.

The strain gauges are used to measure the strain on the thin walled tube **18** in response to a tilting of the assembly **10** away from the horizontal. The tube **18** thus acts as a cantilever beam secured at one end to the upper wall **20** of the outer body portion **12** having a weight W (FIG. 1C) attached to the other end thereof, which weight consists of the inner body portions **16** and its contents comprising an assembly of two ring core flux gate magnetometers **24** and **26** mounted respec-